1,053,390

PATENT SPECIFICATION

DRAWINGS ATTACHED

1,053,390

Date of Application and filing Complete Specification: April 23, 1964.

No. 16803/64.

Application made in United States of America (No. 275,383) on April 24, 1963.

Complete Specification Published: Dec. 30, 1966.

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Index at acceptance:—D1 W(4, 7A, 7X1); D1 FX; D1 M(7, 9, 13, X)

Int. Cl.:—D 01 h // D 01 b, D 02 h

COMPLETE SPECIFICATION

Covered Elastomeric Yarns

We, WYOMISSING CORPORATION, a corporation organised under the laws of the State of Pennsylvania, United States of America, of P.O. Box 742, Reading, Berks County, Pennsylvania, United States of America, do hereby declare the invention, for which we pray that a Patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following Statement:—

The present invention relates to elastomeric yarns, and has particular application to a method and apparatus for covering such yarns with adhesive; or fibrous material and an adhesive.

Prior to the present invention, there has been limited usage of bare elastomeric yarns such as rubber and spandex because of the limited dyeability of the yarns, the handle of the fabrics embodying such yarns, the slipperiness of the yarns and the resulting tendency for raveling, and the difficulties in handling the yarns during the formation of the fabrics due to their excessive elasticity. Accordingly, it has been the practice to cover the elastomeric yarns by twisting or braiding with conventional fibrous textile yarns. The covering operation limits the elasticity of the elastomeric core yarn, but it has been found difficult to control precisely the elasticity of the covered yarn. As a result in fabrics using multiple ends of the covered yarn, there is an inherent non-uniformity among the ends so used. Furthermore, it has been found that the covering material oftentimes cuts into the elastomeric core yarn and causes a weakening of the core yarn in localised areas, and the core yarn may separate within the covering.

With the foregoing in mind, the present invention provides an elastomeric yarn having a covering which is not subject to the disadvantages of conventional yarns of this character.

More specifically, the present invention provides a method and apparatus for covering elastomeric yarns with an adhesive, and in preferred embodiments with fibrous material in the form of adhesively secured discrete fibres.

The invention also provides a method of producing a beam of yarns suitable for use as the warp of a fabric wherein all of the yarn ends in the warp are uniformly stretched relative to their elastic limit and are uniformly covered by adhesive material to limit their recovery from stretch for facilitating the subsequent cloth fabricating and finishing operations.

All of the objects of the invention are more fully set forth hereinafter with reference to the accompanying drawings wherein:

Fig. 1 is a right hand, part sectional, side elevation of apparatus for covering elastomeric yarns in accordance with the present invention,

Fig. 2 is a left hand side elevation of the apparatus shown in Fig. 1,

Fig. 3 is a transverse sectional view taken on the line 3—3 of Fig. 1, and

Fig. 4 is an enlarged transverse sectional view taken on the line 4—4 of Fig. 1.

The present invention is directed to the covering of elastomeric yarns such as rubber and spandex which are characterised by extensibility due to the molecular structure of the fibres comprising the yarn rather than stretchability due to the physical configuration or conformation of the filaments in the yarn. The percentage elongation or extensibility of untreated natural and synthetic non-elastomeric fibres and monofilaments is substantially less than 10% when the elongation is maintained below the elastic limit of the material. When synthetic yarns are texturised to impart stretch thereto, the percentage elongation is increased to approximately 70%, and when such yarns are incorporated into a fabric by weaving, the maximum elongation of the fabric is in the neighbourhood of 35%. Fibre-covered elastomeric yarns made in accordance with the

[*Price 4s. 6d.*]

present invention, however, exhibit extensibility in a woven fabric of as high as 210% and the normal range is between 120% to 200% elongation. The uncovered elastomeric strands have a percentage elongation or extensibility in the order of several hundred.

Referring now to the drawings, the apparatus illustrated therein operates to unwind a series of elastomeric strands from individual packages in a creel, to fibre-cover the strands uniformly, and to collect the fibre-covered strands and wind them on a beam for use as the warp in subsequent fabricating operation. To this end, the elastomeric strands or yarns *Y* are wound on individual packages *P* in a creel shown diagrammatically at 10. The creel includes drive means including individual feed rolls 11 which are positively driven through chains and sprockets 12 to unwind the strands *Y* from their packages *P*. The chains and sprockets are driven from a drive motor 13 of any suitable form. The feed rollers 11 operate to advance all of the yarns *Y* at a uniform rate to gathering rollers 15 which combine the yarns into a sheet *S* of spaced yarn ends.

A comb or reed 16 is preferably positioned after the gathering rolls 15 to maintain the yarns *Y* of the sheet *S* in uniformly laterally spaced parallel relation in their advance through a fibre-covered unit 20. As set forth more fully hereinafter, the unit 20 supplies an adhesive to the yarns in the sheet *S*, deposits fibrous material on the adhesively-coated yarns and cures or sets the adhesive so that the yarns passing from the unit are dry and are not tacky. A second comb or reed 17 is preferably positioned following the unit 20 to ensure that the yarns in the sheet *S* are maintained in spaced parallel array throughout the fibre-covering unit.

To ensure uniform tensioning of the yarns in the sheet in their travel through the fibre-covering unit, a pair of rubber-covered feed rolls 18 engages the sheet *S* and advances it at a rate correlated to the feed rate of the feed rolls 11 so as to maintain all of the yarns *Y* in the sheet at a uniform tension, preferably a tension sufficient to stretch the yarns over 100% to a point in the upper part of the range below the elastic limit, depending on the stretchability desired in the finished yarns. For example, when covering a spandex core yarn, such as "Lycra" (Trade Mark of du Pont), it is preferred to elongate the yarn 300% by driving the rolls 18 four (4) times the rate of the feed rolls 11. When covering a rubber core yarn, the yarn is elongated 230% by driving the rolls 18 three and three tenths (3.3) times the rate of the feed rolls 11. The greater the stretch applied to the yarns during the fibre-covering process, the greater strength will be required to elongate the fibre-covered yarn, inasmuch as the yarn will be restrained by the fibrous material and adhesives in its recovery from stretch and the yarn will therefore, normally be closer to the limit of its elastic recovery. In the present instance, the drive to the feed rolls 18 is synchronised with the drive to the feed rolls 11 by a drive shaft 21 and a chain and sprocket assembly 22 which is adjustable selectively to provide the desired tension. For certain end uses, the yarn need not be fibre-covered, but it may be desired to maintain the yarn at a selected stretch relative to its elastic limit, in which case the application of fibrous material may be omitted, and the process may consist of covering the yarn with an adhesive and setting the same.

From the feed rolls 18, the yarns pass to a warper 23 which includes a comb or reed 24, a warp beam *B* upon which the warp sheet *S* is wound, and a drive roll 25 which is driven from the drive shaft 21 through sprockets and a chain 26 which determine the drive speed of the drive roll 25. The sprockets driving the drive roll 25 are selected to wind up the yarns at a slower speed than the delivery from the feed rolls 18 to slacken the yarn on the beam uniformly to the proper tension for weaving or knitting. For example, when winding the 300% elongated spandex, the drive roll 25 is driven 2.07 times the rate of feed rolls 11 or a little more than ½ the rate of the feed rolls 18 to reduce the elongation to 107%. When winding the 230% elongated rubber, the drive roll is driven 2.60 times the rate of the feed rolls or a little over ¾ the rate of the feed rolls 18 to reduce the elongation to approximately 160%. By using a common drive motor 13 and chain and sprocket connections between the feed rolls 11, the feed rolls 18, and the drive roll 25, the present apparatus ensures proper correlation between the feed rolls and the drive rolls to ensure uniform tensioning of the yarns both during the flocking operation in the fibre-covering unit 20 and upon the beam *B*.

In accordance with the invention, flocking is applied to the uniformly tensioned yarns *Y* of the sheet *S* in the fibre-covering unit 20. To this end, the sheet S is advanced into operative engagement with an adhesive-applying means 30, in the present instance, comprising an adhesive-applicating roll 31 which is partially immersed in a bath of liquid adhesive 32 and is driven as at 33 to apply the adhesive uniformly on the yarns *Y* of the sheet S. It has been found that to provide an effective adhesion of the flock to the yarns, the adhesive must, in itself when cured or set, be elastomeric and have a stretch corresponding to that of the filament being flocked. When covering spandex as the core yarn, we have used a suitable thermoplastic resin adhesive, such as an aqueous emulsion polyurethane foam adhesive supplied by Eastern Colour and Chemical Co. under the trade mark "Ecco Urebond W". When covering rubber, we have used a suitable latex adhesive such as nitrile polymer emulsion supplied by Goodrich Chemical Co. under the

trade Mark "Hycar 1562". The uniform coating of adhesive applied to the yarns not only assures uniform flocking about the circumference of the yarns, but also retards the oxidation of the spandex yarn which may adversely affect the appearance of the yarn. The uniform application of the adhesive to the yarns in the sheet *S* also ensures that when set or cured, the yarns are uniformly limited in their recovery from stretch, so as to maintain the yarns uniformly at the desired tensile stress relative to their limit of elastic recovery. If desired, the adhesive may be warmed to expedite drying and curing or setting thereof in the subsequent stages of the apparatus.

The adhesively-coated yarns *Y* in the sheet *S* are introduced into a flocking chamber 36 which in the present instance, comprises vertical partitions 35 defining therebetween four vertical passageways 37, 38, 39 and 40. As shown, the passageways 37 and 38 are connected at their top, and the passageways 38 and 39 are connected at their bottom, and the passageways 39 and 40 are connected at their top so that air introduced at the inlet 43 passes upwardly through the passageway 37 and 39 and down through the passageways 38 and 40 on its way to the outlet 44. The sheet *S* is passed through slots 45 in the vertical partitions 35 defining the passageways. As shown in Figs. 1, 2, and 3, an inlet blower 47 is associated with the inlet 43 and an exhaust blower 48 is associated with the outlet 44, the exhaust blower having a greater capacity than the inlet blower so as to exhaust a greater volume of air than introduced by the blower 47. For example, the inlet blower 47 may deliver 190 C.F.M., whereas the exhaust blower 48 may withdraw 261 C.F.M. The difference in air is drawn into the flocking chamber 36 through the entrance and exist slots, designated 45*a* and 45*b* respectively, so as to prevent escape of the flocking material. The flocking material is introduced into the incoming air stream, is passed through the flocking chamber where the short fibrous material is partially embedded in the tacky adhesive coating and is thereby adhesively bonded to the elastomeric core yarn. The material which is not adhered to the sheet of yarns *Y* is exhausted from the exhaust blower 48 through a duct 49 into a separating cyclone 51 which accumulates the flocked material from the air stream and exhausts the air through an outlet 52. The flocking is discharged from the cyclone 51 by a metering wheel 53 into the inlet passage 54 of the inlet blower 47. By the same token, if desired, the air exhausted from the outlet 52 may be recirculated by connecting the outlet 52 to the inlet passage 54. When necessary, makeup flock is introduced into the system by depositing it in the cyclone when the apparatus is shut down. Preferably, the incoming air is heated as at 58, for example, by an electrical heating unit. In this manner, the air flowing through the flocking chamber is fully loaded with flocking material and is heated so as to initiate the curing or setting of the adhesive coating on the yarns. When using a thermoplastic adhesive, it has been found that the air may be heated to approximately 220°F, which is substantially below the degradation temperature of the core yarn and the adhesive coating. The flocking material is a textile material which is preferably readily susceptible to dyeing and which imparts to the yarn the desirable characteristics of a conventional textile yarn without reducing the stretchability of the elastomeric yarn *Y* below the level desired for the particular end use. It has been found that when using fibrous material having a fibre length less than 1/32 inch, the fibrous material covers the adhesively-coated yarns uniformly inasmuch as the fibrous material is passed through the sheet of yarns in each of the four vertical passageways 37, 38, 39 and 40, alternating between the upward flow and downward flow so as to expose all surfaces of the yarns in the sheet to the fibrous material. This uniform application of the flocking material to the adhesively-coated yarns assists the adhesive coating to limit the recovery of the stretched yarn so as to cause the completed covered yarn to be under tensile stress.

Following application of flock to the adhesively-coated yarns, the adhesive coating is set or cured. In the present instance, the sheet of yarn is passed continuously through a setting oven 60 which is electrically heated, for example by a heating unit 61 mounted in the underside thereof. For example, when using a thermoplastic adhesive, the oven may be heated to approximately 350°F to heat the covered yarns to approximately 200°F, as they leave the heating oven. When setting or curing the adhesive is performed in line with other operations which may require intermittent interruptions, the oven should be controlled to prevent overheating of the yarn during such interruptions. Alternatively, depending on the properties of the adhesive and the time available, the setting or curing may be accomplished at room temperature. The heated yarns are partially cooled by the inflow of atmospheric air through the open end of the oven, which, if desired, may be unheated so as to serve as a cooling chamber, the flow being induced by reason of the greater volume of the exhaust fan 48 relative to the inlet fan 47. It is noted that the entrance slot 45*a* is substantially smaller than the exit slot 45*b*, so that there is a greater inflow of air through the oven 60 into the passage 40 than from the surrounding atmosphere diectly into the passage 37. Thus, the heating of the yarns in the chamber and oven and the cooling as the yarns pass out of the oven, cures or sets the adhesive so that it is no longer tacky and is stabilised so as to ensure against cohesion between adjacent yarns as they are wound on the beam *B*. If

desired, a separate cooling chamber may be interposed between the oven and the take-up.

The fibre-covered elastomeric yarns produced in accordance with the present invention exhibit superior frictional properties over conventional elastomeric yarns, thereby reducing the tendency of the yarns to ravel or for the ends to slip, as may normally occur in a sewn joint, and increasing the dimensional stability of the fabrics produced therefrom. Furthermore, the flocking does not exhibit any tendency to cut into the core elastomeric yarns as is the case with wrapped yarns. Since all of the yarns on the beam *B* are treated uniformly, the present invention eliminates the non-uniformity in fabrics embodying the conventionally covered yarns which inherently results from the separate individual processing of the yarns prior to the beaming operation.

While the present invention has been herein illustrated and described with relation to a warping operation upon warp yarns, it is not intended to limit the invention to such disclosure. The invention is equally applicable to filling yarns, and to yarns used in braiding. The covering operation may be performed in conjunction with a rewinding or spooling operation, or other conventional textile operations. The fibre-covered yarn of the present invention renders it possible to braid elastomeric yarns on conventional braiding machines since the process increases the amount of tension that may be applied for a given amount of stretch, thereby enabling the yarn to be unwound from the braider carrier without the jerky motions which have characterised previous attempts to braid bare elastomeric yarns and which have resulted in non-uniform products. Fibre-covered yarns in accordance with the present invention produce improved dimensional stability in braided products.

WHAT WE CLAIM IS:—

1. A method of covering elastomeric yarns with adhesive material to control the modulus and stretch of said yarns comprising the steps of disposing a plurality of elastomeric yarns in spaced relation, elongating all of said core yarns uniformly a predetermined degree, coating the stretched individual yarns with an elastomeric adhesive having an elongation when set or cured similar to the elongation of the elastomeric core yarns, and thereafter curing or setting said elastomeric adhesive to eliminate substantial tackiness thereof on said elastomeric yarns while elongated, and winding said cured or set coated yarns on at least one package, said adhesive coating restraining said core yarns against complete recovery from elongation.

2. A method according to claim 1, wherein said adhesive has an elongation when set or cured operable to restrain said core yarns from relaxing to their original length.

3. A method as claimed in claim 1 or claim 2, including the step of depositing loose fibrous material on the uniformly stretched coated yarns prior to the curing or setting of the elastomeric adhesive to adhesively bond said fibrous material to said elastomeric yarns.

4. A method according to any one of claims 1 to 3, wherein curing or setting of the adhesive coating is effected by heating the covered yarns prior to winding.

5. A method according to claim 3, wherein heating of the yarns is effected both simultaneously with and subsequent to the depositing of fibrous material on said yarns.

6. A method according to claim 4 or claim 5, including the step of cooling said heated yarns prior to winding.

7. A method according to any one of the preceding claims, wherein said adhesive coating is applied in a liquid state to completely coat said elastomeric yarns and protect them from exposure to the atmosphere when set or cured.

8. A method according to claim 3, wherein the depositing of said fibrous material upon said coated yarns embeds the fibrous material in said coating to adhesively bond said material to the yarns.

9. A method according to claim 3, wherein said depositing is effected by blowing air laden with the fibrous material across said yarns, first in one direction and then in the opposite direction.

10. A method according to claim 3, wherein the elongation of the core yarns is below the elastic limit of said yarns.

11. A method of covering elastomeric yarns with fibrous material, comprising the steps of disposing a plurality of packages of uncovered elastomeric yarns in a creel having individual feed means for each yarn package, driving each of said feed means at a uniformly constant surface speed to effect a constant rate of feed, gathering the individual uncovered elastomeric yarns into a sheet of spaced yarns, engaging and advancing said sheet of individual yarns at a rate correlated to the rate of feed of said creel feed means so as to stretch said yarns, coating said stretched elastomeric yarns with an elastomeric adhesive having an elongation when cured or set similar to the elongation of said elastomeric core yarns, depositing on said coated stretched elastomeric yarns a covering of short fibrous material to adhesively secure said material to said yarns, thereafter curing or setting said adhesive coating while said yarns are stretched to stabilize said coating against tackiness, and uniformly winding said sheet of yarns onto a warp beam to constitute a warp of fibre-covered elastomeric yarns.

12. A method according to claim 11, wherein said advancing rate is correlated to the feed rate to stretch the elastomeric core yarns below the elastic limit of said yarns.

13. A method according to claim 11 or 12, wherein said depositing is effected by blowing air laden with fibrous material transversely

through said sheet of individual elastomeric yarns in several passes and in opposite directions, to thereby thoroughly cover said coated yarns with fibrous material.

14. A method according to claim 13, wherein said curing or setting of the adhesive coating is initiated simultaneously with the depositing by using heated air for blowing through said sheet, and is continued by passing said fibre-covered sheet through an oven and into the atmosphere whereby said sheet is heated to curing temperature and is thereafter cooled by the atmosphere.

15. A method of covering elastomeric yarns with adhesive material to control the modulus and stretch of said yarns substantially as hereinbefore described with reference to and as illustrated in the accompanying drawings.

16. Apparatus when used for covering elastomeric yarns in accordance with the method of claims 11 to 14, comprising a creel for receiving individual packages of uncovered elastomeric yarns and including individual feed means for advancing said yarn from said packages at a predetermined rate, said feed means for all of said individual yarns being driven in synchronism to advance all of said yarns uniformly at the same rate, guide means to direct said yarns and position them in spaced parallel array in a common plane to form a sheet of individual yarns; feed rolls operable to engage said sheet and advance the same, drive means for said feed rolls synchronized with the feed means in said creel to advance said sheet in timed relation to said creel feed means, a flocking station intermediate said feed rolls and said guide means, said flocking station including means to apply elastomeric adhesive to said sheet of yarns to coat the individual yarns, means to apply fibrous material to said coated yarns so as to cover said yarns with said fibrous material, means to cure or set said adhesive subsequent to said flocking operation; and means to collect said sheet of covered elastomeric yarns from said feed rolls.

17. Apparatus according to claim 16 wherein said flocking station includes a flocking chamber having partitions defining plural air passages therein, means in said partitions defining slots for advancing said sheet transversely through said passages in sequence, means to introduce air laden with fibrous material into a passage at one end of the chamber, means to withdraw said air from a passage at the opposite end of the chamber and means to direct said air longitudinally in sequence through said plural passages in opposite directions, and an oven connected to said flocking chamber to receive the sheet passing from said last passage to effect curing or setting of said adhesive by heat.

18. Apparatus according to claim 17, wherein said means to introduce air comprises an inlet blower operable to discharge a given volume of air into said chamber, and said means to withdraw air from said chamber comprises an exhaust blower operable to withdraw a volume of air greater than said given volume, said oven being operable to afford passage of air therethrough from the atmosphere into said chamber to be withdrawn from said chamber by said exhaust blower.

19. Apparatus according to claim 18, including a separator to receive the air from said exhaust blower and separate the non-deposited fibrous material therefrom, and means operable to discharge said separated fibrous material into the air introduced into said chamber by said inlet blower.

20. Apparatus according to any one of claims 16 to 19, including common drive means for said individual feed means, said feed rolls, and said collecting means; and chain and sprocket connections therebetween affording accurate correlation thereof to tension the yarns.

21. Apparatus for covering elastomeric yarns constructed and arranged substantially as herein described with reference to the accompanying drawings.

22. Covered elastomeric yarn when made by the method of any one of claims 1 to 10.

23. Fibre-covered elastomeric yarn when made by the method of any one of claims 11 to 14.

24. Fibre-covered elastomeric yarns when produced on the apparatus claimed in any one of claims 16 to 21.

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Leamington Spa: Printed for Her Majesty's Stationery Office, by the Courier Press (Leamington) Ltd.—1966. Published by The Patent Office, 25 Southampton Buildings, London, W.C.2, from which copies may be obtained.

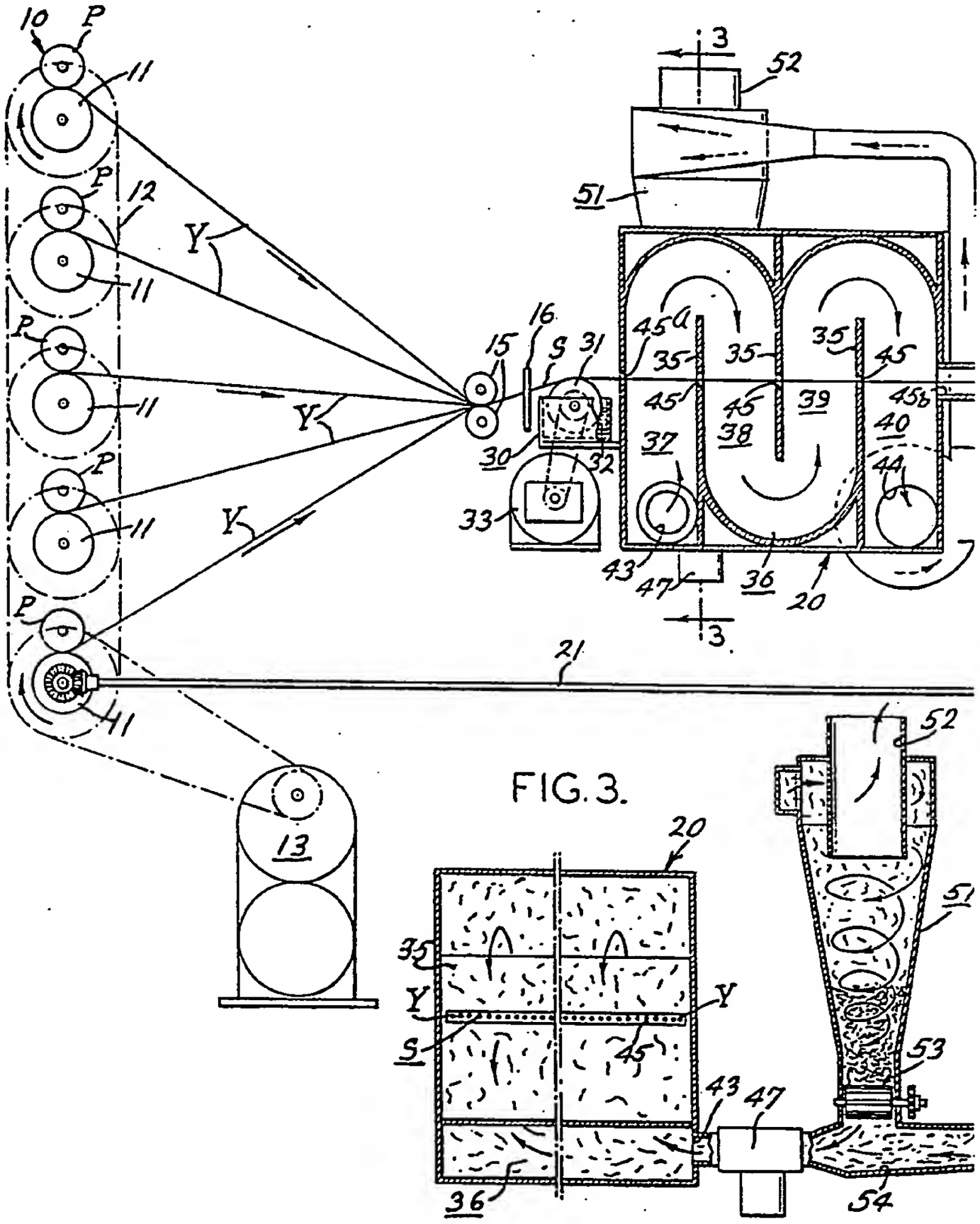
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FIG. 3.

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FIG.1.

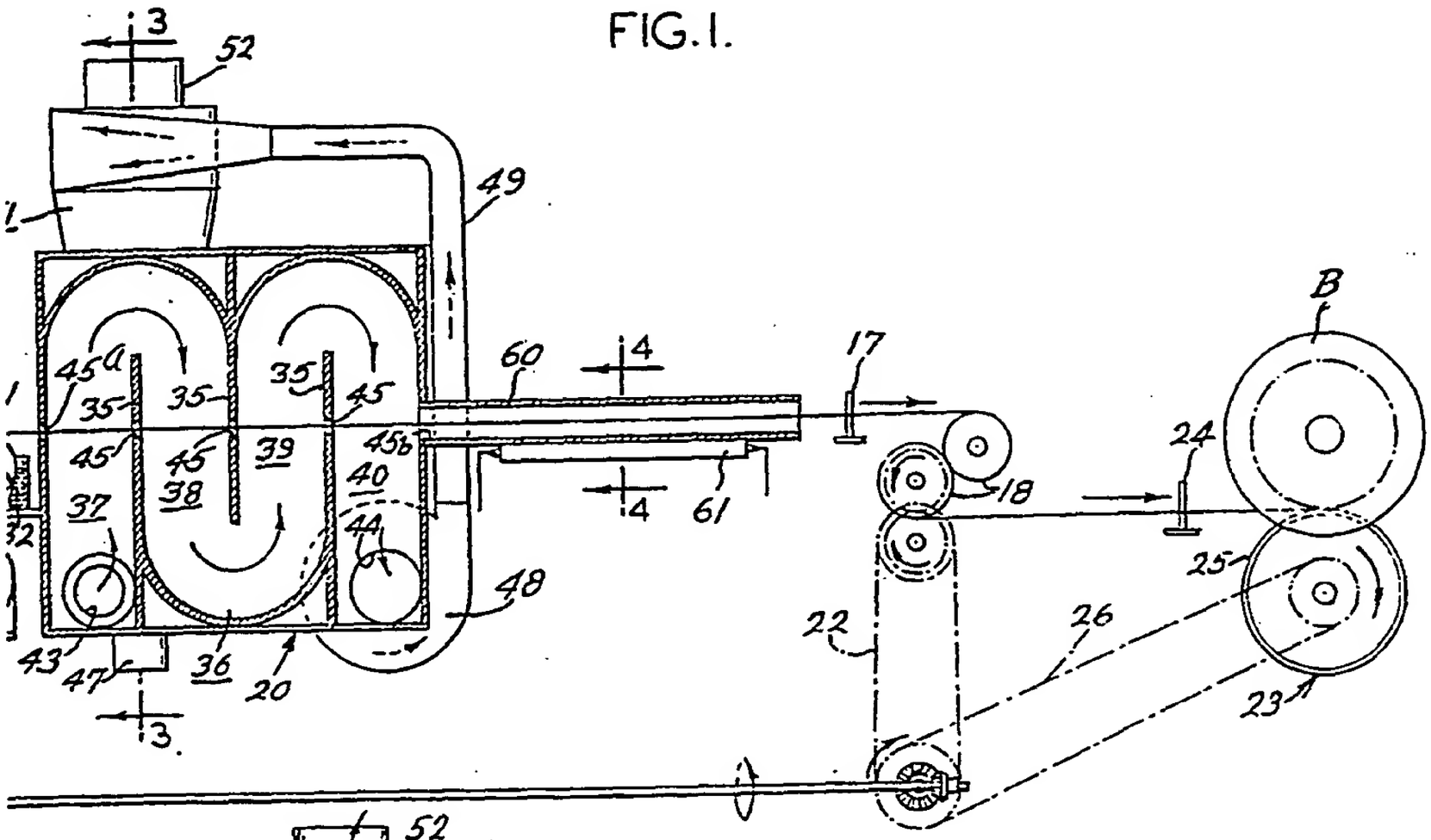
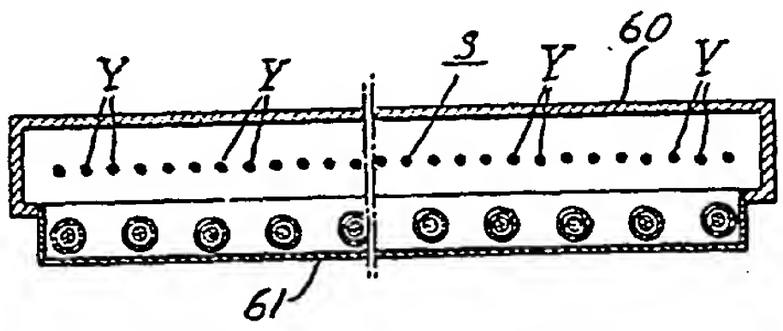


FIG.4.



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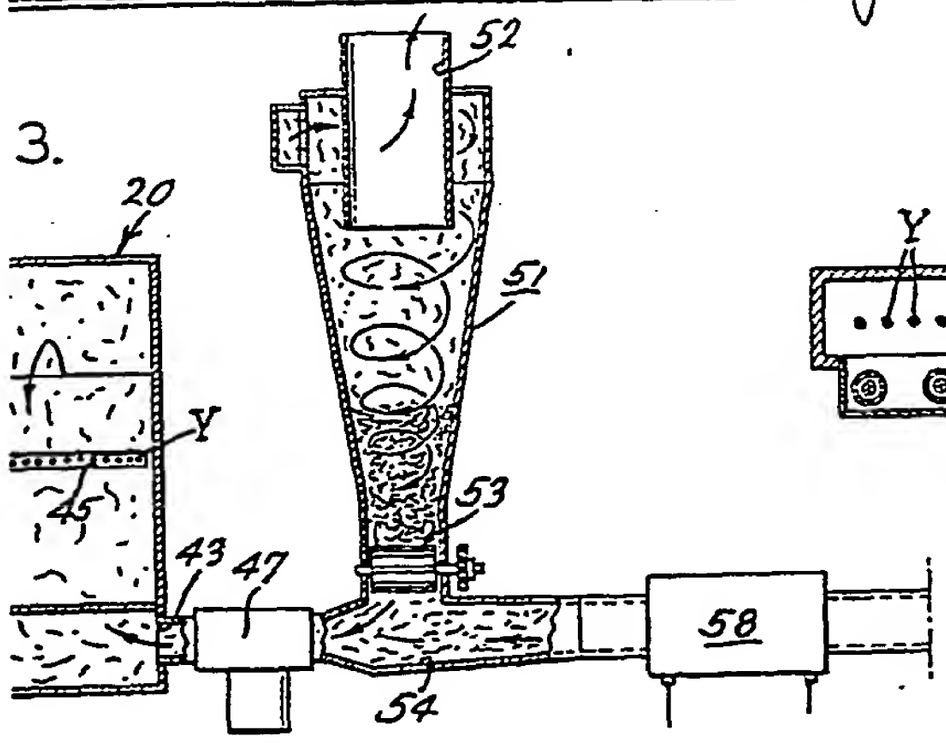

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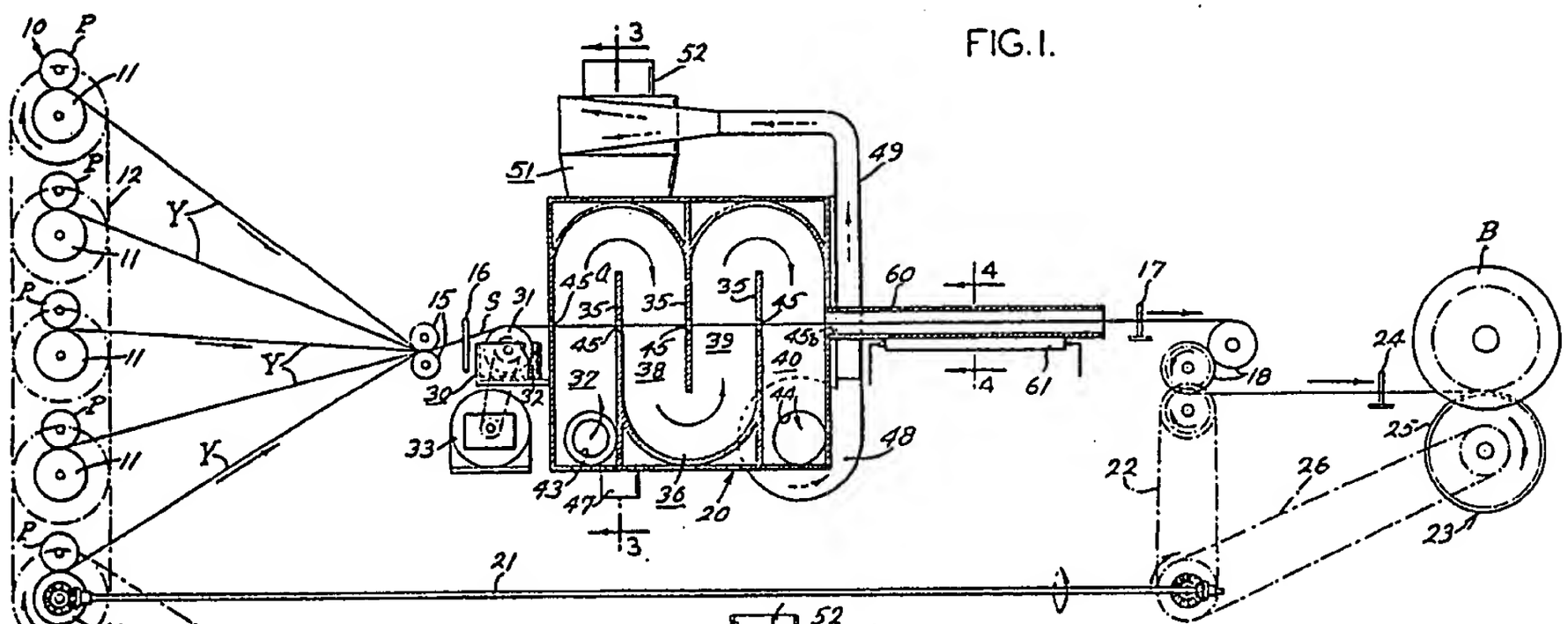
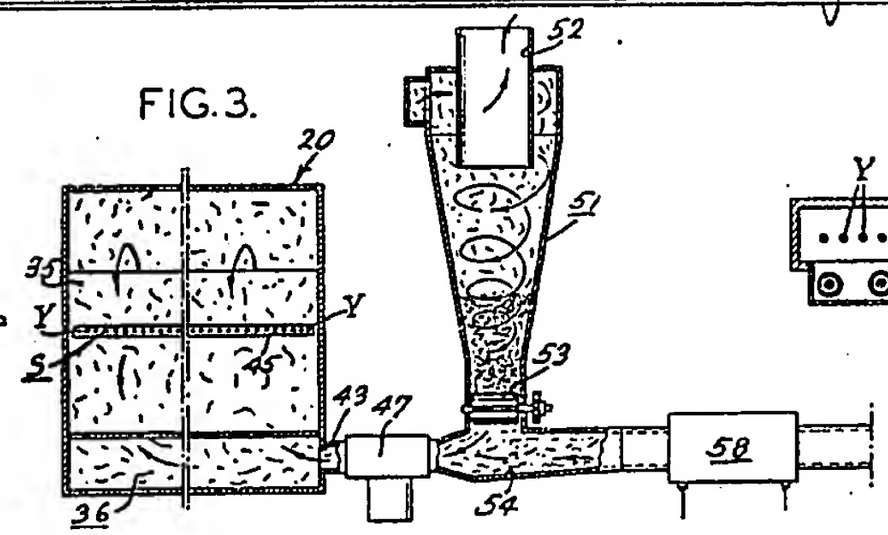


FIG. 1.



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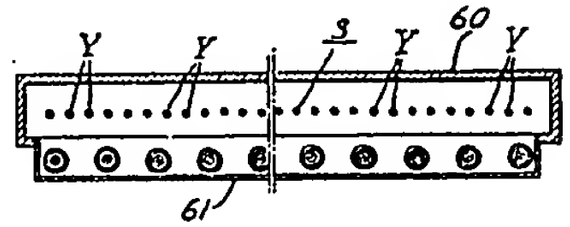
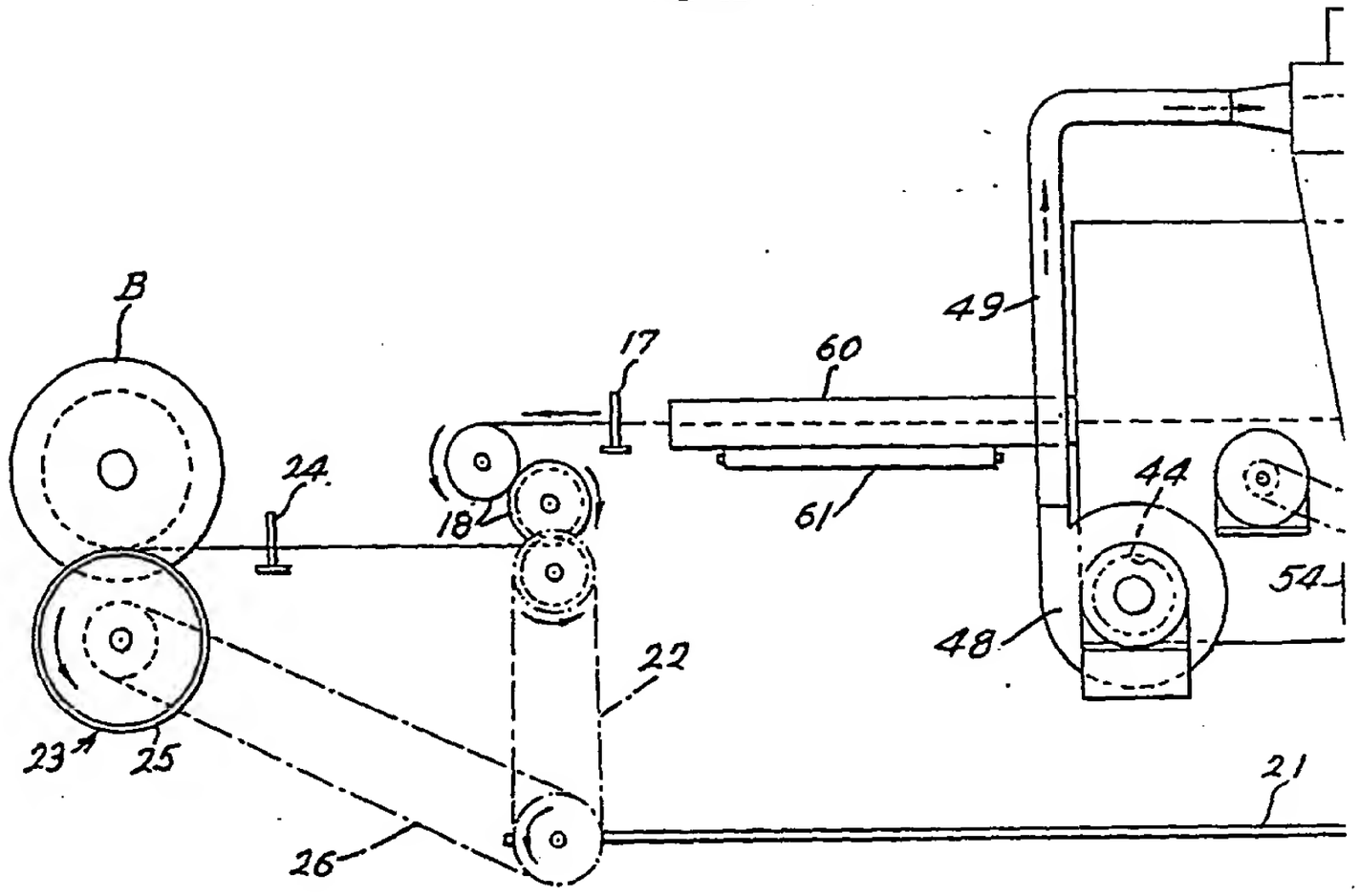


FIG. 4.

FIG.2.



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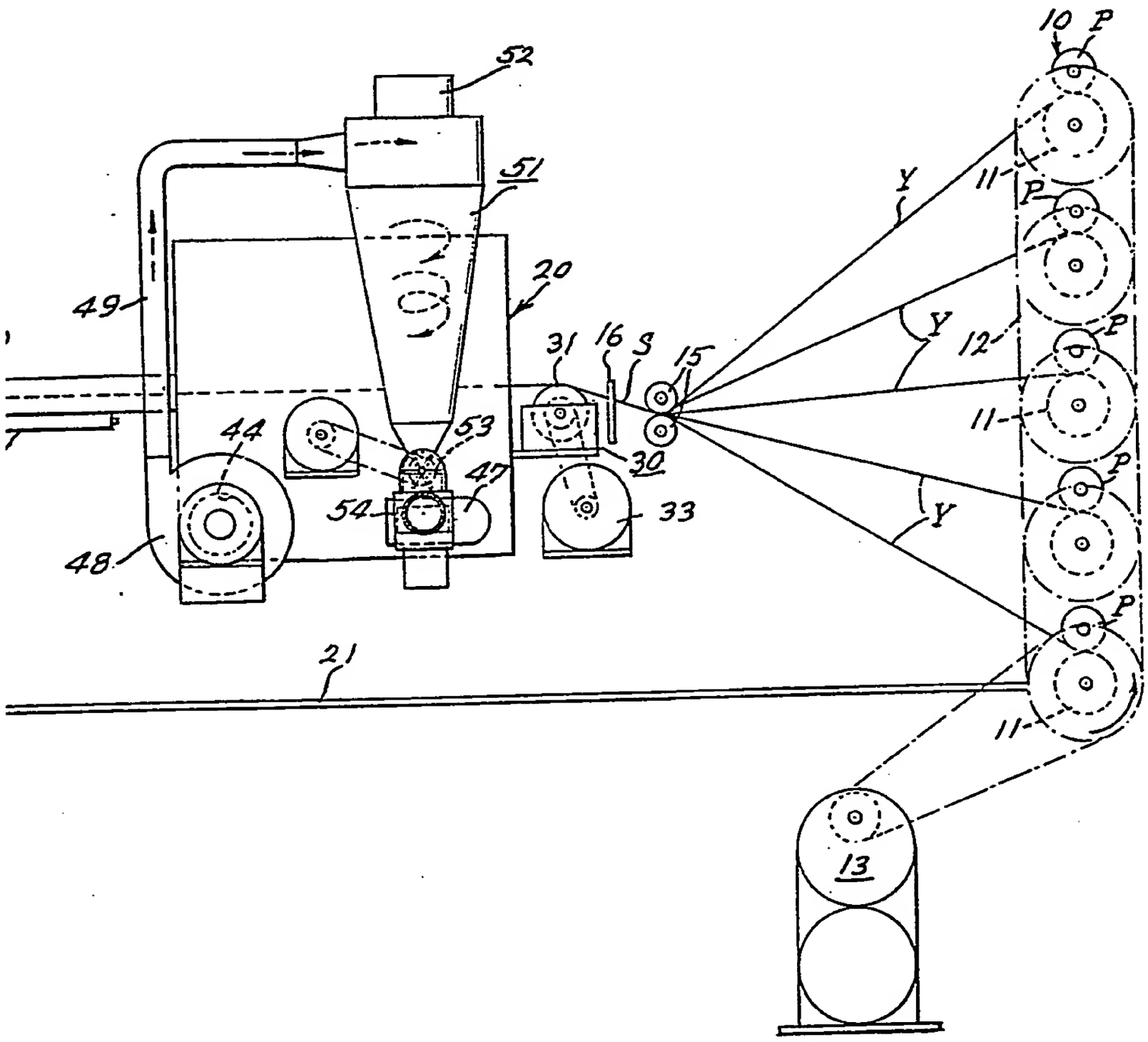

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FIG.2.